DECLARATION

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do hereby declare that:

1) I am conversant with the English and Korean languages and am a competent translator therebetween;

2) To the best of my knowledge and belief, the attached is a true and correct translation of the priority applications No. 10-2004-0023695 for the U.S Patent Application No. 10/564,406

Signed this 22th day of September, 2008

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【Request for Examination】 Requested

【Purpose】 The application is filed under Article 42 and Examination of the application is requested under Article 60.

【Fee】

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【Additional filing Fee】	19 Sheets	0 Won
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[ABSTRACT]

Disclosed is light emitting device including: a light emitting chip; and a phosphor through which a first light emitting from the light emitting chip passes, wherein the phosphor comprises a first silicate phosphor exciting a second light having a first centered emission peak using the first light and a second silicate phosphor exciting a third light having a second centered emission peak using the first light, the first centered emission peak is in a range of 550 - 600 nm, and the second centered emission peak is in a range of 500 - 550 nm. The first silicate phosphor has a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x (0 < x \leq 1)$. The second silicate phosphor has a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x (0.001 \leq x \leq 1)$.

According to the present invention, provided is a white light emitting diode having higher CCT and CRI than a conventional light emitting diode using a YAC:Ce phosphor, and color coordinate, CCT, and CRI are controlled by changing a mixing ratio of a yellow silicate phosphor and a green sulfide phosphor.

[REPRESENTATIVE DRAWING]

FIG. 1

[INDEX WORD]

yellow silicate phosphor, greed silicate phosphor, light emitting diode

[SPECIFICATION]

[TITLE OF THE INVENTION]

PHOSPHOR AND WHITE LED USING THE SAME

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a sectional view of a white light emitting device manufactured in an SMD type according to the spirit of the present invention;

Fig. 2 is a sectional view of a light emitting device manufactured in a vertical lamp type according to the spirit of the present invention;

Fig. 3 is a graph of a light emission spectrum of a light emitting device according to the present invention; and

Fig. 4 is a graph showing an emission spectrum emitting from a light emitting device according to the present invention when a mixing ratio of a phosphor mixed in a phosphor layer of the light emitting device.

<DESCRIPTION OF THE SYMBOLS IN MAIN PORTIONS OF THE DRAWINGS>

110,210: Leadframe   130,230: light emitting chip of InGaN

150,250: Wire

170,270: light emitting epoxy resin or light emitting silicon resin

172,272: Yellow silicate phosphor   174, 274: Green silicate phosphor

[DETAILED DESCRIPTION OF THE PRESENT INVENTION]

[OBJECT OF THE PRESENT INVENTION]

[FIELD OF THE INVENTION AND DESCRIPTION OF THE RELATED ART]

The present invention relates to a light emitting device and phosphor thereof, and more particularly, to a mixed type phosphor where yellow silicate phosphor and silicate green phosphor are mixed, and a white light emitting device emitting white light using the mixed phosphor.

Methods for manufacturing a general GaN white light emitting device are generally classified into two methods, one is a method using a single chip, in which a

white light emitting device is obtained by further forming a phosphor layer on a blue light emitting device or a UV light emitting device, and the other is a method using a multi-chip, in which two or more light emitting devices are combined to obtain a white light emitting device. The white light emitting device is exemplified by a white light emitting diode (LED), but is not limited thereto.

A representative method to realize a white light emitting device in the form of a multi-chip is manufactured by combining three R, G and B light emitting devices. However, the multi-chip type light emitting device has a drawback in that respective chips have non-uniform operation voltages and outputs of the respective chips are varied depending on a surrounding temperature, so that a color coordinate is changed.

Owing to the above reason, the multi-chip type is suitable for a specific lightening purpose that requires various color reproductions by adjusting each of LED brightness through circuit configurations rather than the white light emitting device

Accordingly, a binary system having an easy fabrication and superior efficiency is representatively used for realizing the white light emitting device. The binary system allows white light to be emitted by combining a blue light emitting device with a yellow phosphor layer, which is excited by the blue light emitting device to emit yellow light.

In detail, the binary system is a light emitting device, which uses the blue LED as an excitation light source and excits YAG (Yttrium Aluminum Garnet) phosphor using rare-earth 3-valent ion of $Ce3+$ as an activator, i.e., YAG:Ce phosphor using an excitation light emitted from the blue LED.

Also, the white light emitting device employs various packages according to its applications, and representatively includes a surface mounting device (SMD) type ultra-miniaturized light emitting device used in a backlight of a handheld terminal, and a vertical lamp type light emitting device used for an electronic board, a solid display device or an image display.

Index for analyzing the characteristics of white light includes a correlated color temperature (CCT) and a color rendering index (CRI).

In detail, the CCT indicates a temperature of an article when the article shines with emitting visible rays, it seems that a color of the article is identical to a color that a black body radiates at a temperature and it is assumed that the temperature of the black body is equal to that of the article. As CCT increases, the light dazzles a human being and becomes a bluish white.

Therefore, in spite of identical white lights, when the CCT is low, people feel more warm, whereas when the CCT is high, people feel cold. Accordingly, by adjusitng the CCT, it is possible to meet even the specification of a particular lighting requiring various color feelings.

In a conventional white light emitting device using YAG:Ce phosphor, since the CCT is fixed only to 6000 - 8000 K, it is impossible to display various color feelings by adjusting the CCT.

The CRI indicates a degree that the color of an article is changed when sun light or artificial light is irradiated onto the article. When the color of the article is identical to that under sun light, the CRI is defined 100. In other words, the CRI is an index to show how the color of the article under the artificial lighting is close to that under sun light, and has a value of 0 to 100.

Accordingly, as the CRI approaches 100, i.e., white light, people can feel that the color of the article under the artificial lighting has no difference than that under sun light.

At present, an incandescent lamp has a CRI of more than 80 and a fluorescent lamp has a CRI of more than 75, while a white LED using YAG:Ce phosphor has a CRI of approximately 70 - 75, which is low relative to those of the incandescent lamp and the fluorescent lamp.

Accordingly, it is problematic that the white LED using the conventional YAG:Ce phosphor is narrow in CCT and relatively low in CRI not to realize a complete white light.

Moreover, because only the YAG:Ce phosphor is used, it is difficult to control color coordinate, CCT, and CRI.

[TECHNICAL OBJECT OF THE INVENTION]

It is therefore an object of the present invention to provide a white light emitting device having high CCT and CRI by using a phosphor mixed with a yellow silicate phosphor and a green silicate phosphor instead of a white light emitting device using a conventional YAC:Ce.

It is another object of the present invention to provide a white light emitting device capable of controlling color coordinate, CCT, and CRI by changing a mixing ratio of a yellow silicate phosphor and a green sulfide phosphor.

[CONSTITUTION AND OPERATION OF THE INVENTION]

In one embodiment, a light emitting device includes: a light emitting chip; and a phosphor through which a first light emitting from the light emitting chip passes, wherein the phosphor comprises a first silicate phosphor exciting a second light having a first centered emission peak using the first light and a second silicate phosphor exciting a third light having a second centered emission peak using the first light, the first centered emission peak is in a range of 550 - 600 nm, and the second centered emission peak is in a range of 500 - 550 nm.

The first silicate phosphor may have a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x (0 < x \leq 1)$ and the second silicate phosphor may have a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x (0.001 \leq x \leq 1)$.

In another embodiment, a light emitting device includes: a leadframe; a light emitting chip emitting a light; a connection part for electrically connecting the leadframe with the light emitting chip; a phosphor encapsulating and molding the light emitting chip and through which the light passes; a first silicate phosphor contained in the phosphor and having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x (0 < x \leq 1)$; and a second silicate phosphor contained in the phosphor and having a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x (0.001 \leq x \leq 1)$.

In further another embodiment, a light emitting device includes: a leadframe; a light emitting chip emitting a light and mounted on the leadframe; a connection part for electrically connecting the leadframe with the light emitting chip; a phosphor of a multi-

structure encapsulating and molding the light emitting chip and through which the light passes; a silicate phosphor contained in the phosphor and having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x(0 < x \leq 1)$; and a sulfide phosphor contained in the phosphor and having a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x(0.001 \leq x \leq 1)$.

The first silicate phosphor having a centered emission peak of 500 - 600 nm and the second silicate phosphor having a centered emission peak of 500 - 550 nm, excited by a blue light (400 – 480 nm) emitted from a nitride compound semiconductor, are mixed with the phosphor layer, and are molded around the light emitting chip. The first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 1 to 1 : 9 or 9 : 1 to 1 : 1. A light emitting diode chip of InGaN is largely used as the nitride compound semiconductor.

The first silicate phosphor may have a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x(0 < x \leq 1)$, and the second silicate phosphor may have a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x(0.001 \leq x \leq 1)$.

When the phosphors are mixed with a mold material, the first silicate phosphor and the second silicate phosphor may exist at a ratio of 1 : 1 to 1 : 9 or 9 : 1 to 1 : 1.

The phosphor may have a particle size of $d_{90} \leq 20$ ㎛, $5 \leq d_{50} \leq 10$ ㎛.

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to accompanying drawings.

Figs. 1 and 2 are schematic views illustrating a white emitting diode according to the present invention.

Fig. 1 is a sectional view of a white light emitting device manufactured in an SMD type according to the spirit of the present invention. Fig. 2 is a sectional view of a light emitting device manufactured in a vertical lamp type according to the spirit of the present invention.

Referring to Fig. 1, the SMD white light emitting device of the present invention includes: leadframes110 having anode and cathode; a light emitting chip 130 of InGaN

for generating light having a centered emission peak in a range of 400 - 480 nm when a voltage is applied; a wire 150 serving as a connection part for conduction between the leadframes110 and the light emitting chip 130; a phosphor layer 170 provided in the form of a molded light transmitting epoxy resin or an light transmitting silicon resin around the light emitting chip 130.

In detail, the phosphor layer 170 includes a yellow silicate phosphor 172 having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}{}_x(0 < x \leq 1)$ and a green sulfide phosphor 174 having a chemical formula of $Sr_{1-x}Ga_2S_4:Eu^{2+}{}_x(0.001 \leq x \leq 1)$, the bodies 172 and 174 being mixed therein. Since the phosphor layer 170 is molded around the light emitting chip 130, the light emitted from the light emitting chip 130 excites the phosphors 172 and 174 so that light desired by a user, e.g., white light may be emitted.

Here, the mixing ratio of the yellow silicate phosphor 172 and green sulfide phosphor 174 mixed in the phosphor layer 170 may be 1:1 to 1:9 or 9:1 to 1:1.

Particularly, in the case where the light emitting device is used in the form of a top view, the mixing ratio of the yellow silicate phosphor 172 and green sulfide phosphor 174 may be 1:2 to 1:3.

Also, in the case where the light emitting device is used in the form of a side view, the mixing ratio of the yellow silicate phosphor 172 and green sulfide phosphor 174 may be 1:3 to 1:4.

Here, silicon resin can be used as the molding material instead of the epoxy resin.

On the other hand, the phosphor of the present invention is formed between printed circuit board and a key pad stacked on the printed circuit board such that it can be used as a backlight source that lightens the key pad.

At this point, in the case where light of the light emitting device is white, the green phosphor and the yellow phosphor are mixed at a ratio of 1:2 - 1:5 and the content of the phosphors in the light transmitting resin may be 15 - 30wt%. Also, in the case where light of the light emitting device is bluish white, the green phosphor and the yellow phosphor are mixed at a ratio of 1:2 - 1:5 and the content of the phosphors in the light

transmitting resin may be 5 - 10wt%.

Fig. 2 is a sectional view of a light emitting device manufactured in the form of a vertical lamp type according to another embodiment of the present invention.

Referring to Fig. 2, the light emitting device of a vertical-lamp type includes: a pair of leadframes 210; a light emitting chip 230 of InGaN mounted on the leadframes210; a wire 250 serving as a connection part for electrically connecting the leadframes 210 with the light emitting chip 230; a phosphor layer 270 enclosing the entire surrounding of the light emitting chip 230; and an enclosure material 280 at the outside of the phosphor layer 270. The phosphor layer 270 is provided in a state where predetermined fluorescent bodies are mixed into an light transmitting epoxy resin or a light transmitting silicon resin. The phosphor layer 270 encloses the outer space of the light emitting chip 230. Also, the phosphor layer 270 in a resin state is molded around the light emitting chip 230.

Like the first embodiment, the phosphor layer 270 includes yellow silicate phosphor 272 having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}{}_x(0 < x \leq 1)$and green sulfide phosphor 274 having a chemical formula of $Sr_{1-x}Ga_2S_4:Eu^{2+}{}_x(0.001 \leq x \leq 1)$, the phosphors 272 and 274 being mixed therein, so that light desired by a user, e.g., white light may be emitted.

In more detail, the yellow silicate phosphor 272 having a centered emission peak of 500 - 600 nm and the green sulfide phosphor 274 having a centered emission peak of 500 - 550 nm, excited by a blue light (400 – 480 nm) emitted from the light emitting diode chip 230, are mixed with the phosphor layer 270, and are molded around the light emitting chip 230.

At this point, when power is applied to the light emitting chip 230, the light emitting chip 230 emits blue light having the wavelength of 400 - 480 nm. Light having a centered emission peak of 550 - 600nm is excited in the yellow silicate phosphor 272 by blue light, and light having a centered emission peak of 500 - 550 nm is excited in the green sulfide phosphor 274.

Here, a mixing ratio of the yellow silicate phosphor 272 and the green sulfide phosphor 274, mixed with the phosphor layer 270, is 1:1 to 1:9 or 9:1 to 1:1.

In detail, in the light emitting chips 130 and 230 of InGaN, the blue light having the wavelength of 400 - 480 nm is emitted and passes through the phosphor layer 270. At this point, part of the emitted light excites the yellow silicate phosphors 172 and 272 and green sulfide phosphors 174 and 274 while passing through the phosphor layer 270.

Therefore, the light having a centered emission peak of 550 - 600 nm is excited in the yellow silicate phosphors 172 and 272 and the light having a centered emission peak of 500 - 550 nm is excited in the green sulfide phosphors 174 and 274.

Referring to Fig. 3, light having a wide range of wavelengths ranged from 400nm to 700nm is emitted from the light emitting device.

Fig. 4 is a graph of a light-emission spectrum of light emitted from a light emitting device when a mixing ratio of the yellow silicate phosphors 171 and 272 and the green sulfide phosphors 174 and 274 mixed into the phosphor layer 170 or 270 of the inventive light emitting device changes.

Fig. 4 illustrates (a) a light-emission spectrum line due to only the green sulfide phosphor, (b) a light-emission spectrum line due to only the yellow silicate phosphor, (c) a light-emission spectrum line for the case where the green sulfide phosphor and the yellow silicate phosphor are mixed at the ratio of 3: 1, (d) a light-emission spectrum line for the case where the green sulfide phosphor and the yellow silicate phosphor are mixed at the ratio of 5: 1, and (5) a light-emission spectrum line for the case where the green sulfide phosphor and the yellow silicate phosphor are mixed at the ratio of 7: 1. Though light having the wavelength less than 500 nm is not illustrated, it is easily expected that light emitted from the blue light emitting chip 230 and that does not pass through the phosphor corresponds to that light.

As described in Fig. 4, it is possible to control the characteristics of the light from the light emitting device by changing the content ratio of the green sulfide phosphor and the yellow silicate phosphor. Also, it is possible to control color coordinates, CCT, CRI

by controlling the characteristic of the emitted light. Therefore, the state of light can be controlled to the direction as desired by a user.

[EFFECT OF THE INVENTION]

The present invention provides a white light emitting diode having higher CCT and CRI than a conventional light emitting diode using a YAC:Ce phosphor.

Additionally, the present invention controls color coordinates, CCT, and CRI by changing a mixing ratio of a yellow silicate phosphor and a green sulfide phosphor.

Moreover, the present invention provides a white light emitting diode used as an energy saving light source instead of a backlight for color LCD, an LED lamp, and an interior LED or fluorescent lamp of a train or a bus.

This invention has been described above with reference to the aforementioned embodiments. It is evident, however, that many alternative modifications and variations will be apparent to those having skill in the art in light of the foregoing description. Accordingly, the present invention embraces all such alternative modifications and variations as fall within the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. A light emitting device comprising:

a light emitting chip; and

a phosphor through which a first light emitting from the light emitting chip passes,

wherein the phosphor comprises a first silicate phosphor exciting a second light having a first centered emission peak using the first light and a second silicate phosphor exciting a third light having a second centered emission peak using the first light,

the first centered emission peak is in a range of 550 - 600 nm, and

the second centered emission peak is in a range of 500 - 550 nm.

2. The light emitting device according to claim 1, wherein the first silicate phosphor has a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}_x(0 < x \leq 1)$.

3. The light emitting device according to claim 1, wherein the second silicate phosphor has a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}_x(0.001 \leq x \leq 1)$.

4. The light emitting device according to any one of claims 1 to 3, wherein the first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 1 to 1 : 9 or 9 : 1 to 1 : 1.

5. The light emitting device according to any one of claims 1 to 3, wherein the phosphor has a particle size of $d_{90} \leq 20$ ㎛, $5 \leq d_{50} \leq 10$ ㎛.

6. A phosphor of a light emitting device, comprising:

a first silicate phosphor excited by a light generated by a light emitting chip and

having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}{}_x(0 < x \leq 1)$; and

a second silicate phosphor excited by the light generated by the light emitting chip and having a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}{}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}{}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}{}_x(0.001 \leq x \leq 1)$.

7. A light emitting device comprising:

a leadframe;

a light emitting chip emitting a light;

a connection part for electrically connecting the leadframe with the light emitting chip;

a phosphor encapsulating and molding the light emitting chip and through which the light passes;

a first silicate phosphor contained in the phosphor and having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}{}_x(0 < x \leq 1)$; and

a second silicate phosphor contained in the phosphor and having a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}{}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}{}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}{}_x(0.001 \leq x \leq 1)$.

8. The light emitting device according to claim 7, wherein the first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 1 to 1 : 9 or 9 : 1 to 1 : 1.

9. The light emitting device according to claim 8, wherein when the light emitting device is a top view type, the first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 2 to 1 : 3.

10. The light emitting device according to claim 14, wherein when the light emitting device is a side view type, the first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 3 to 1 : 4.

11. A light emitting device comprising:

a leadframe;

a light emitting chip emitting a light and mounted on the leadframe;

a connection part for electrically connecting the leadframe with the light emitting chip;

a phosphor of a multi-structure encapsulating and molding the light emitting chip and through which the light passes;

a silicate phosphor contained in the phosphor and having a chemical formula of $Sr_{3-x}SiO_5:Eu^{2+}{}_x(0 < x \leq 1)$; and

a sulfide phosphor contained in the phosphor and having a chemical formula of $Ba_{2-x}SiO_4:Eu^{2+}{}_x$, $Ca_{1-x}MgSi_2O_7:Eu^{2+}{}_x$ or $Sr_{1-x}Ga_2S_4:Eu^{2+}{}_x(0.001 \leq x \leq 1)$.

12. The light emitting device according to claim 11, wherein the first silicate phosphor and the second silicate phosphor exist at a ratio of 1 : 1 to 1 : 9 or 9 : 1 to 1 : 1.

FIG. 1

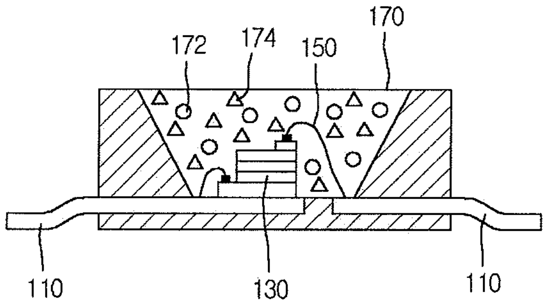


FIG. 2

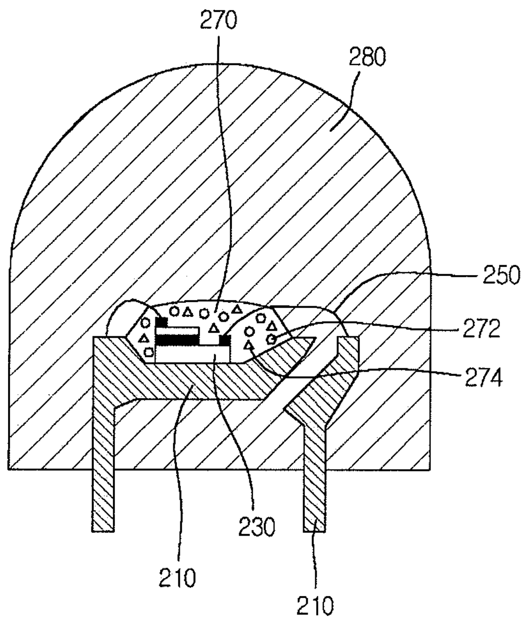


FIG. 3

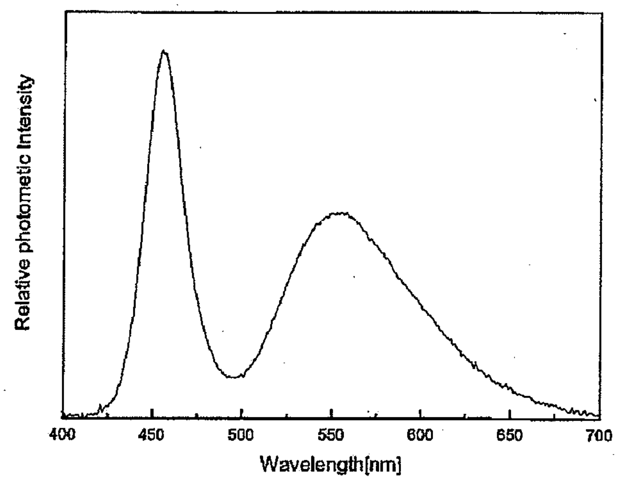
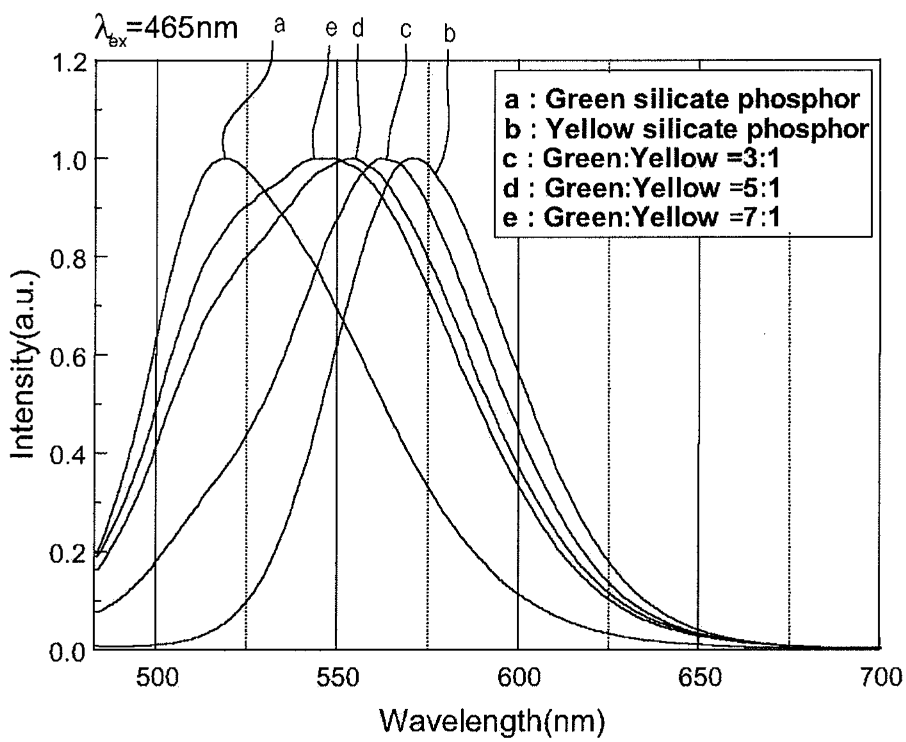

Relative photometic Intensity
400
450
500
550
600
650
700
Wavelength[nm]

FIG. 4


λ_{ex}=465nm
a
e
d
c
b
a : Green silicate phosphor
b : Yellow silicate phosphor
c : Green:Yellow =3:1
d : Green:Yellow =5:1
e : Green:Yellow =7:1
Intensity(a.u.)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
500
550
600
650
700
Wavelength(nm)